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VCE Chemistry ½
Introduction to Organic Chemistry [2.5]
Workbook

Outline:

Learning Objectives:

- ☐ **CH12 [2.5.1]** - Molecular, Structural, Semi-structural and Skeletal Formulae of Straight-Chained & Branched Alkanes
- ☐ **CH12 [2.5.2]** - Write IUPAC Names of Branched & Unbranched Alkanes
- ☐ **CH12 [2.5.3]** - Write Molecular, Structural, Semi-structural and Skeletal Formulae of Straight-Chained & Branched Haloalkanes
- ☐ **CH12 [2.5.4]** - Write IUPAC Names of Branched & Unbranched Haloalkanes
- ☐ **CH12 [2.5.5]** – Identify and Draw Simple Cycloalkanes & Write Their IUPAC Names

Section A: Introduction to Organic Chemistry

Sub-Section: Introduction to Organic Chemistry

Context

- **Three** different types of **intra**molecular bonds:
  - _____.
  - _____.
  - _____.
- **Organic Chemistry:** _____ bonds, as they occur between non-metals.

Active Recall: What are covalent bonds?

_____

Discussion: What elements do all living things contain?

Space for Personal Notes

Exploration: Carbon Covalent Bonding

- Organic Chemistry is the study of compounds of **Carbon**.
- **Carbon:**

Number of Protons	Number of Electrons	Electron Configuration

- Valence electrons: _____
- Electrons needed: _____
- **Conclusion:** Carbon can form _____ covalent bonds!
- **Visualisation:**

Wants to 'gain' 4 more electrons to obtain a full outer shell by forming 4 covalent bonds.

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How do we name organic molecules?

Exploration: Naming Organic Compound Basics

Longest Carbon Chain Length	Prefix
1	
2	
3	
4	
5	
6	
7	
8	

TIP: Carbon lengths from **5-8** are the same as the prefixes for **shape**!

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Sub-Section: Representation of Organic Molecules

Context

- Organic compounds generally have _____, _____, _____ and _____ atoms.
- Multiple ways to express an organic molecule:
  - Molecular Formula.
  - Structural Formula.
  - Semi-Structural Formula.
  - Skeletal Formula.

Let's have a look at what these look like together!

Molecular Formula

- **Definition**: Indicates the _____ of each atom which makes up a molecule.
- **Example**:

$$C_3H_8O$$

Carbon (C) atoms	Hydrogen (H) atoms	Oxygen (O) atoms

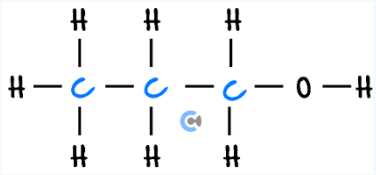
Discussion: What is a major downside of the molecular formula?

- No indication of the _____.

Use the structural formula instead!

Exploration: Structural Formula

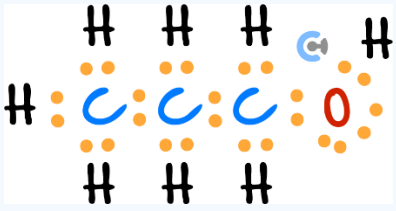
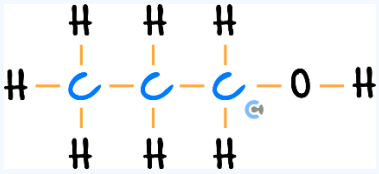
- Consider Propan-1-ol:

Molecular Formula	Structural Formula
C_3H_8O	

- **Structural formula** - Can the way the atoms are arranged be seen? [Yes] / [No]
- **Structural formula** - Can the number of each atom be determined? [Yes] / [No]

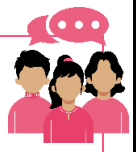
NOTE: We'll cover what propan-1-ol (an alcohol) is later on!

Exploration: Lewis Dot Structure vs Structural Formula

	Lewis Dot Structure	Structural Formula
Structure		
Covalent Bonds	Shows [electrons] / [bonds].	Shows [electrons] / [bonds].
Lone Pairs	Lone pair electrons [shown] / [not shown].	Lone pair electrons [shown] / [not shown].

Discussion: What are two things required in an exam with time pressure?

- _____.
- _____.

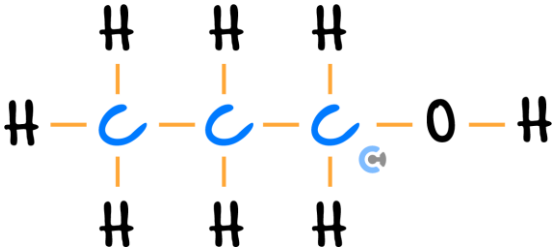


Discussion: What might be a downside of drawing a structural formula?

While the structural formula is good, there's a condensed version!

Exploration: Semi-Structural Formula (Condensed Structural Formula)

- Structural formula for propan-1-ol:



- Draw a 'bubble' around each **Carbon** and the atoms it's bonded to. *(Draw Above)*
- **Representation:**

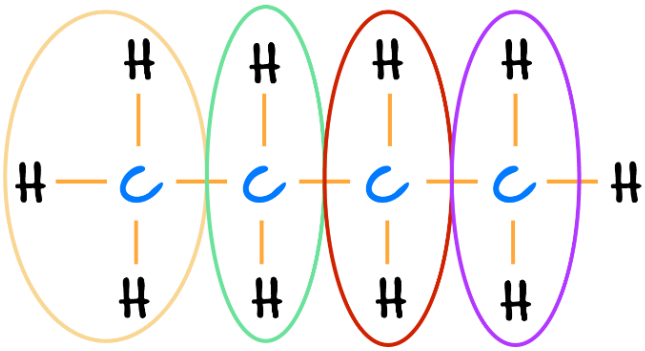
Semi-Structural Formula #1	Semi-Structural Formula #2

NOTE: Either of the above versions are accepted by VCAA!

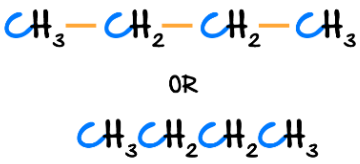
Semi-Structural Formula

- **Definition:** Semi-structural formula is a more **compact** way of drawing the structural formula, and is also known as the _____ structural formula.
- It is written by writing the _____ of atoms surrounding each carbon atom.

Structural Formula



Semistructural Formula



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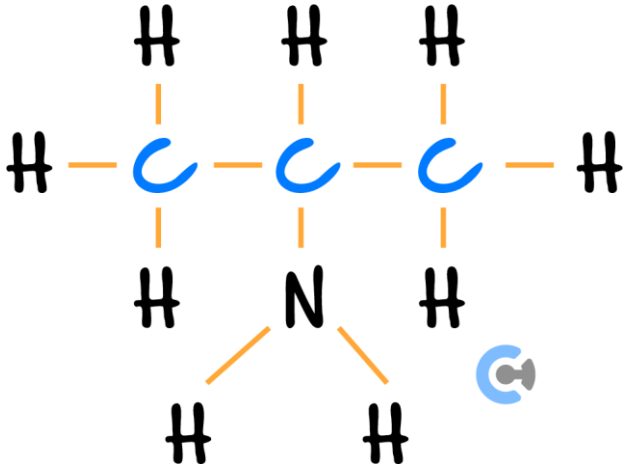
Let's have a look at a question together!

Question 1 Walkthrough.

For each of the following:

Represent the molecule in the way specified, and state the relevant prefix for the number of carbons.

a. Structural formula:



Semi-structural formula: _____

Prefix: _____

b. Draw the structural formula of a molecule which has a semi-structural formula of $CH_3CHOHCH_2CH_3$.

Prefix: _____

TIP: Look between two carbons in the semi-structural formula to know what is on each carbon!

Recall!

Active Recall: Prefixes for the following number of carbons:

Longest Carbon Chain Length	Prefix
1	
2	
3	
4	
5	
6	
7	
8	

Space for Personal Notes

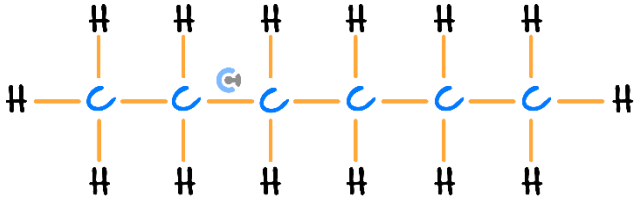
Your Turn!

Question 2

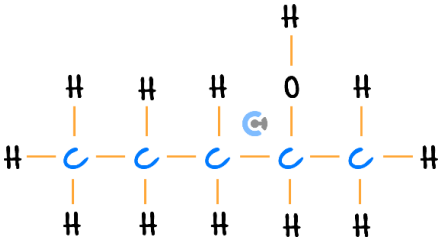
The structural formula for the following molecules is provided.

Write the semi-structural formula for each of them, and state the prefix indicating the number of carbons in the molecule.

a.



b.



Question 3

The semi-structural formula for the following molecules is provided. Draw the structural formula for each of them, and state the prefix indicating the number of carbons in the molecule.

a. CH_3CH_3

b. $CH_3CH_2CH_2NH_2$

Space for Personal Notes

Sub-Section: Skeletal Structure

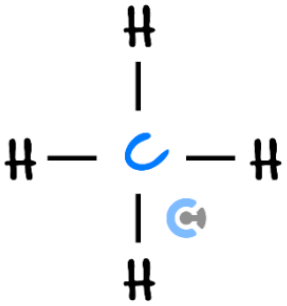
Context

- One more representation: _____ structure.

Before looking at skeletal structures,
let's first have a look at molecular geometry!

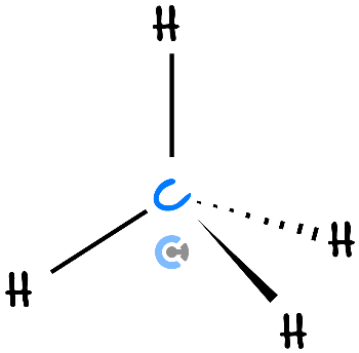
Exploration: Molecular Geometry of Organic Molecules

- **Consider methane:**



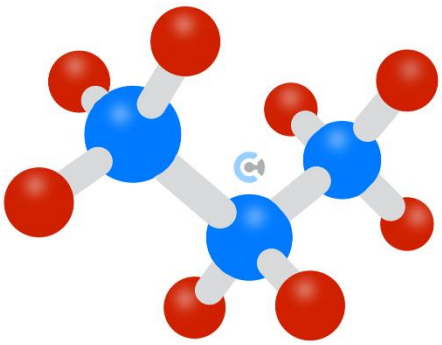
  - The geometry of methane is _____ - not actually a square shape.

- **More accurately:**



- However, VCAA allows the 'square' drawing conventions.

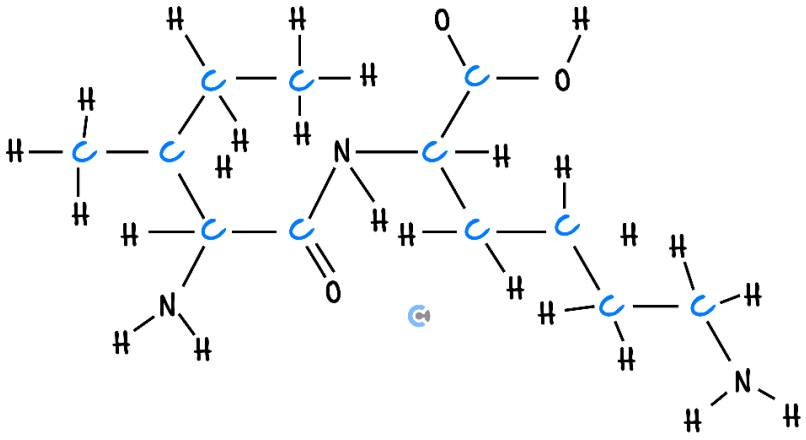
- Propane (C_3H_8) should have a shape like the following:



- **Depictions:**

'More accurate' Structural Formula	'Less accurate' Structural Formula

- VCAA final exam:
  - *Inspired from VCAA Chemistry Exam 2021*
    https://www.vcaa.vic.edu.au/Documents/exams/chemistry/2021/2021chem-w.pdf



  - The structure is given in the 'more accurate' form, but **not** required.

TIP: For SACs, do what your teachers want. For the final exam, do whichever!

Active Recall: Which element is the backbone of organic chemicals?

_____

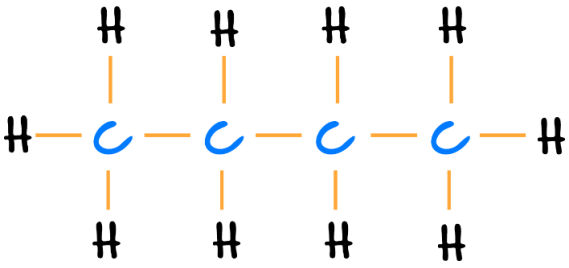
Active Recall: How many bonds does carbon typically form?

_____

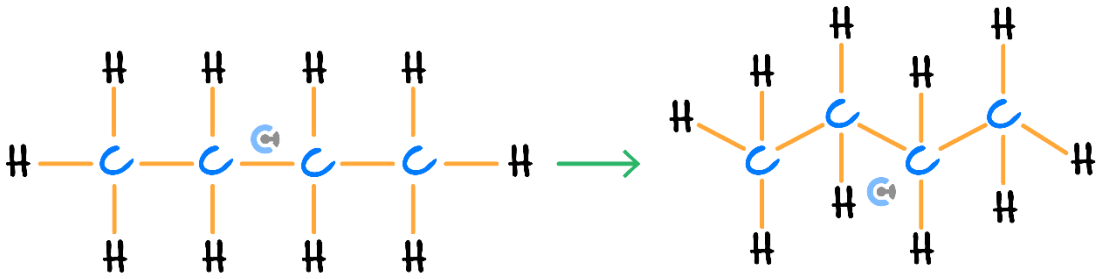
Let's have a look at skeletal structures now!

Exploration: Skeletal Structure

- Each carbon in the **backbone** is typically bonded to _____ to obtain **four** covalent bonds!
- **Conclusion:** [Do] / [do not] include **carbon** and **hydrogen** in the skeletal structure!
- Consider butane (C_4H_{10}):



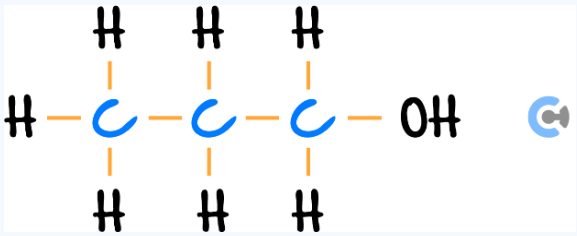
- **Reality**: Backbone is angled. *(Highlight below)*



- **Redrawn:**

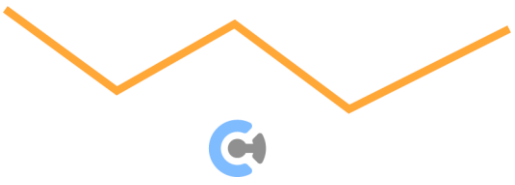
  - Any intersection/end is assumed to be a _____ atom.
  - The lines are assumed to be a _____ between adjacent carbon atoms.

- **Consider propan-1-ol (C_3H_8O):**

Structural Formula	Skeletal Formula
	

Misconception

"The skeletal formula for butane (C_4H_{10}) consists of four lines - one line for each carbon."



TRUTH: Each intersection or end counts as a carbon.
If we have four lines, that results in 5 overall ends/intersections,
meaning that pentane (alkane with 5 carbons) is represented instead.

- Proper skeletal representation:

NOTE: We'll cover skeletal structures more in-depth as we go on, so don't worry too much right now!

Let's cover the first organic class of molecules, which are alkanes!

Space for Personal Notes

Section B: Alkanes

Sub-Section: Straight-Chained Alkanes

Hydrocarbons

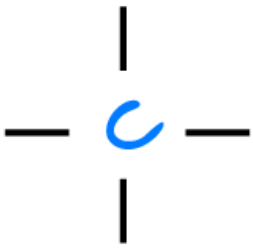
- **Definition:** An organic compound that only consists of the following elements:
  - _____.
  - _____.

Active Recall: How many bonds does hydrogen want to form to obtain a full outer shell?

_____

Exploration: First Alkane

- Consider the following carbon atom:



  - Hydrogens attached: _____ *(Draw Above)*
- Carbons present: _____
  - Prefix: _____
- **Name:** _____

Alkanes

- **Definition: Hydrocarbons** that only contain _____ bonds.

TIP: Remember **alkane** as:

$$alk - ane$$

- '-ane' starts with 'a', the _____ vowel - standing for carbon-carbon _____ bonds.

Exploration: Different Representations of Alkanes

- **First 3 alkanes:**

Number of Carbons	1	2	3
Name			
Structural Formula			
Semi-Structural Formula			
Skeletal Formula			
Molecular Formula			

TIP: When drawing skeletal formulas, 'start counting' how many points by starting with the dot.

Exploration: Molecular Formulas of Alkanes

Alkanes	Semi-Structural Formula	Molecular Formula
Methane	CH_4	CH_4
Ethane	$CH_3 - CH_3$	C_2H_6
Propane	$CH_3 - CH_2 - CH_3$	C_3H_8
Butane	$CH_3 - CH_2 - CH_2 - CH_3$	C_4H_{10}
Pentane	$CH_3 - CH_2 - CH_2 - CH_2 - CH_3$	C_5H_{12}

- **Pattern:**

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Let's have a look at a question together!

Question 4 Walkthrough.

Represent heptane in each of the following ways:

a. Molecular Formula and semi-structural formula.

Molecular Formula	Semi-Structural Formula

b. Skeletal structure.

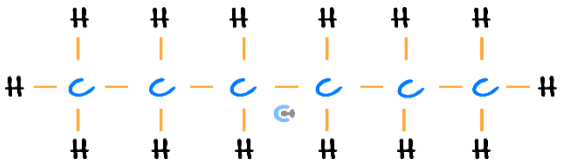
REMINDER: The general molecular formula of an alkane is _____.

NOTE: When there are multiple $-CH_2-$ groups, they can be condensed!

- E.g. _____

Question 5

Name the following molecule, and write the molecular formula.



_____

Your Turn!

Question 6

Find the molecular formula and draw the semi-structural and skeletal formulae for each of the following molecules.

a. Pentane.

i. Molecular Formula and semi-structural formula.

Molecular Formula	Semi-Structural Formula

ii. Skeletal structure.

b. Octane.

i. Molecular Formula and semi-structural formula.

Molecular Formula	Semi-Structural Formula

ii. Skeletal structure.

Question 7 Additional Question.

Without drawing the structural or skeletal formula, state the condensed semi-structural formula of butane.

_____

Space for Personal Notes

Sub-Section: Branching

So far, we've been assuming that carbons will be connected to each other in a linear chain. However, carbons can also start to branch!

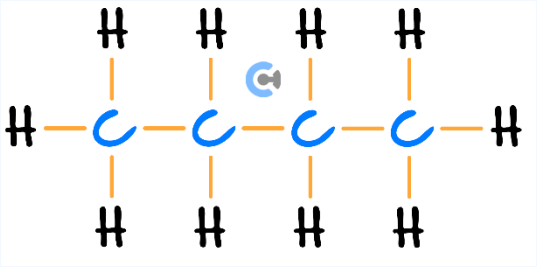
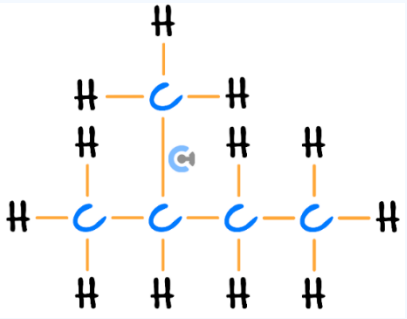
Exploration: Branching

- Consider butane:

  - Instead of filling extra bonds with hydrogen, fill one with another carbon. *(Draw Above)*

- **Branches:**
  - Extra carbon on top: [Side] / [Main] branch
  - Four carbons on bottom: [Side] / [Main] branch.
- Main vs side branch: _____.
- Side branches are called _____ chains.
- In this scenario, carbons in the side chain: _____
  - Side chain name: _____

- Naming entire molecule:add alkyl chain as a **prefix,** following it with '-yl':

Original Molecule	New Molecule
	

Let's properly cover how to name the molecules systematically!

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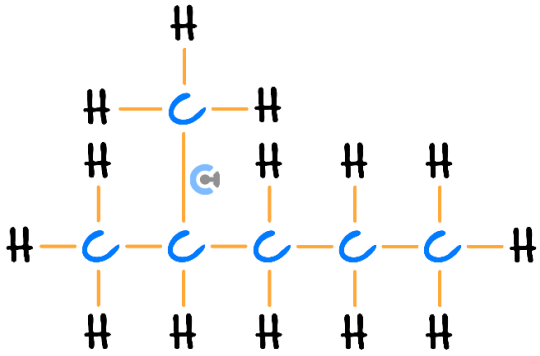
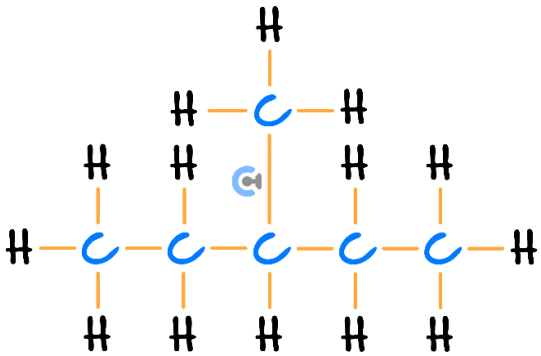
Sub-Section: Naming Organic Molecules (IUPAC Conventions)

Context

- Must follow the International Union of Pure and Applied Chemical (**IUPAC**) standards.

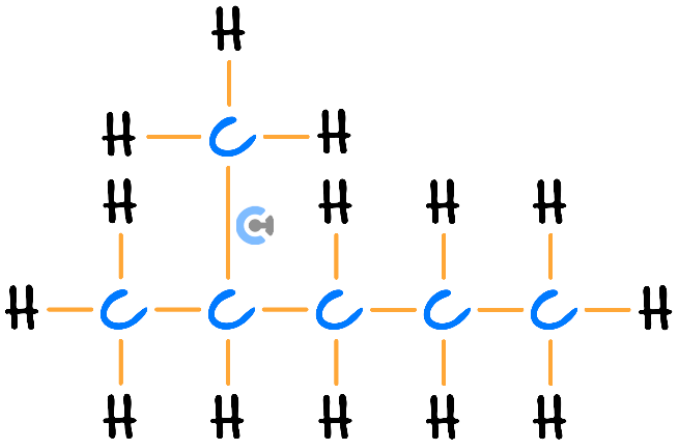
Exploration: Introduction to IUPAC Nomenclature

- Consider pentane with a side branch:

Arrangement 1	Arrangement 2
	

- Difference: _____.

- **Arrangement 1**:



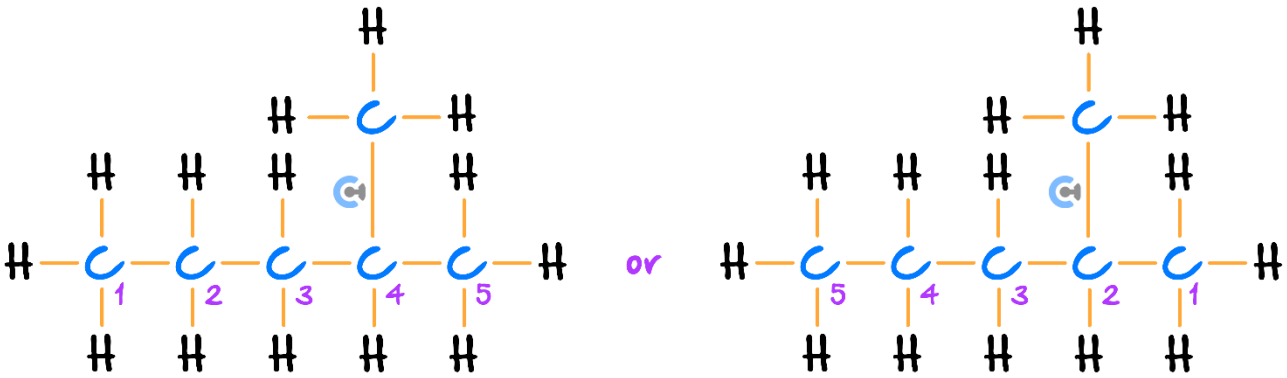
- Where is the main chain? *(Highlight Above)*

- Which side is the methyl group closest to? [Left] / [Right]
  - **Number** carbons in the main chain starting with the side methyl group is **closest** to! *(Label Above)*
  - Carbon number the methyl group is on: _____.
- **Rules:**
  - The number is indicated at the **beginning**.
  - **No spaces** in the name (apart from esters and carboxylic acids).
  - Numbers and letters separated by dashes (–).
- Name: _____
- Depicting **side chains in semi-structural: _____.**
  - Semi-Structural Formula:
- Skeletal structure:

Space for Personal Notes

Misconception

"The following molecule can be named as 2-methylpentane or 4-methylpentane depending on which side we start naming from."



4 – methylpentane

2 – methylpentane

TRUTH: We have to always start naming the molecule from the side where the functional groups are closest to.

NOTE: In 3D, you can rotate them and they are the same thing.

NOTE: These molecules exist in 3D space where they are constantly moving and can rotate, which is why '4-methylpentane' is just 2-methylpentane!

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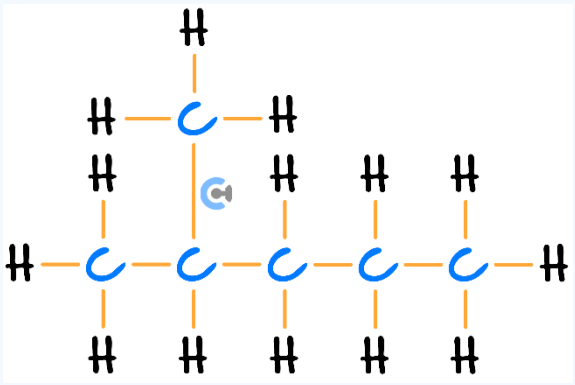
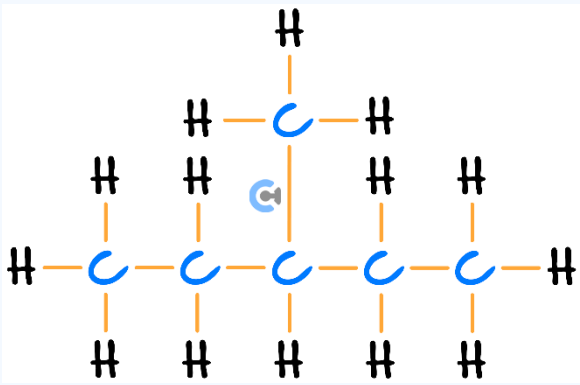
Now, let's compare the two arrangements of the methylpentane!

Exploration: Alkyl Group on Different Carbons

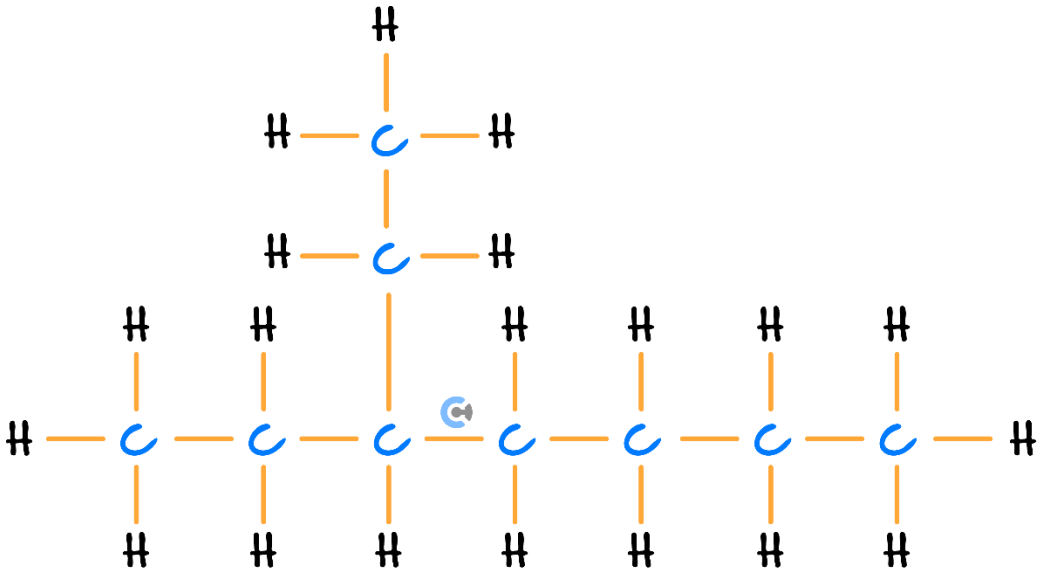
Arrangement 1	Arrangement 2
	
Name 2-methylpentane	**Name**
Semi-Structural $CH_3CH_2(CH_3)CH_2CH_2CH_3$	**Semi-Structural**
Skeletal 	**Skeletal**

Space for Personal Notes

What about longer side chains?

Exploration: Longer Side Chains

- Consider the following molecule:



  - Side chain name: _____
  - Side chain on carbon: _____
  - Main chain name: _____
- IUPAC name: _____

IUPAC Naming Conventions #1

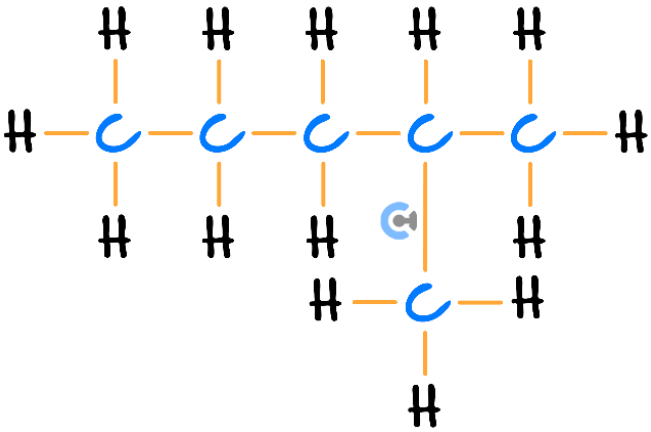
- The [main] / [side] branch has **less** carbons.
- Side branches: _____ chains, named using '-yl'.
- The position of a branch is indicated by a number at [beginning] / [end].
- There [are] / [are no] **spaces** in a name, (apart from esters and carboxylic acids).
- Numbers and letters separated by _____.

Try Some Questions !

Question 8

Name each of the following molecules & draw their semi-structural and skeletal formulas.

a.

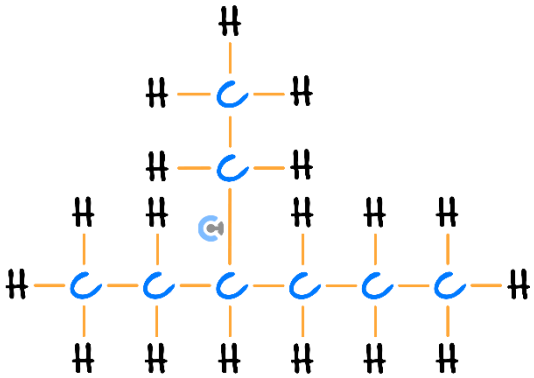


i. Name and semi-structural formulas.

Name	Semi-Structural Formula

ii. Skeletal structure.

b.



i. Name and semi-structural formulas.

Name	Semi-Structural Formula

ii. Skeletal structure.

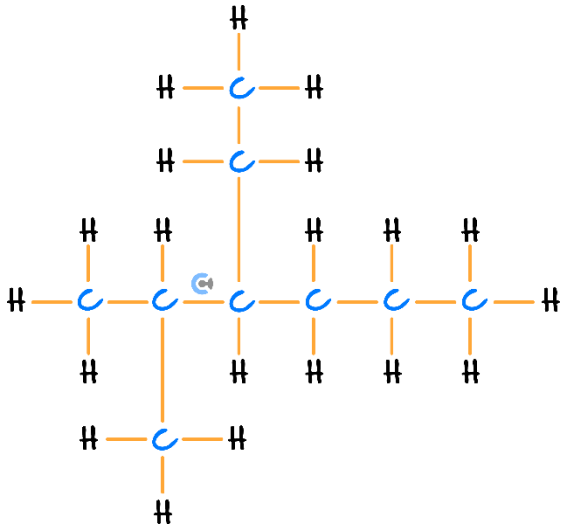
Space for Personal Notes

Sub-Section: Multiple Sidechains

Sometimes, there are molecules with multiple side chains. Let's have a look at a few examples together!

Exploration: Two Different Sidechains

- Consider the following molecule:



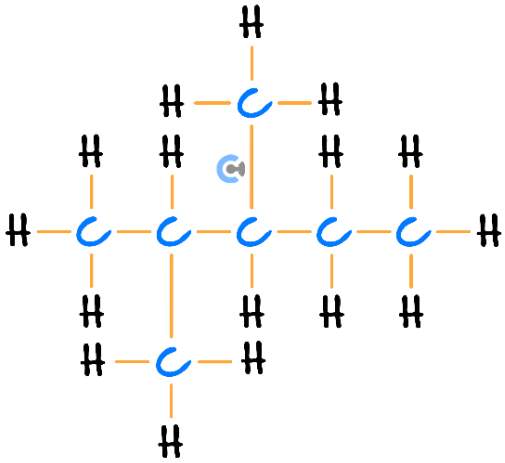
- Where is the main chain? Where are the sidechains? How long are the sidechains? *(Label Above)*
  - Two sidechains. Reference first: **[methyl] / [ethyl]**
- Multiple side chains: Name them according to _____ order.
- Name: _____

REMINDERS

- Numbers and letters are separated by dashes (–).

Exploration: Two Same Sidechains

- Consider the following molecule:



- Where is the main chain? Where are the sidechains? How long are the sidechains? *(Label Above)*
- Two of the same sidechain – reference as:

2-methyl-3-methylpentane

- Both sidechains are 'methyl' - can be grouped together: _____.
- Name: _____

NOTE: Numbers and numbers are separated by _____!

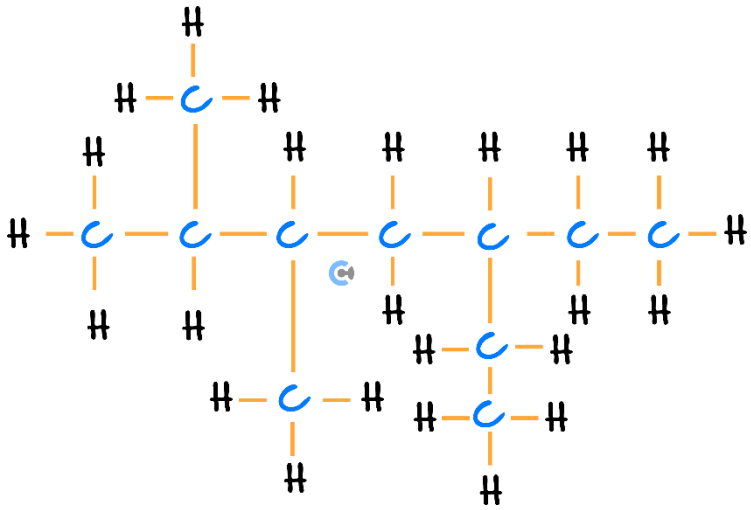
IUPAC Naming Conventions #2

- **Alphabetical Order:** Different functional groups are listed _____ at the start of the name.
- **Multiple of Same Group:**
  - Use prefixes: _____.
  - Each group is numbered for position on the carbon chain.
- **Number Separation:** _____

Let's look at one more example together!

Exploration: Same and Different Side Chains

- Consider the following molecule:



- Where is the main chain? *(Highlight Above)*
- Where are the sidechains? *(Label Above)*

Which side do we start numbering the carbons from?

- New Idea: _____
- Sidechain with priority: [Shorter methyl groups] / [Longer ethyl groups]
- Side start numbering from: [Left] / [Right]
- Side chain naming:
  - Ethyl group is called 'ethyl'.
  - Two methyl groups are called 'dimethyl'.
- What comes first alphabetically? [ethyl] / [dimethyl]
- Prefixes such as 'di-', _____ counted: only compare the 'ethyl' and 'methyl' alphabetically!
- Name: _____

IUPAC Naming Conventions #3

- Two side chains of different lengths: Priority is given to the [shorter] / [longer] side chain.
- When naming, [do] / [do not] count 'di-, tri- or tetra-' when comparing alphabetical order.

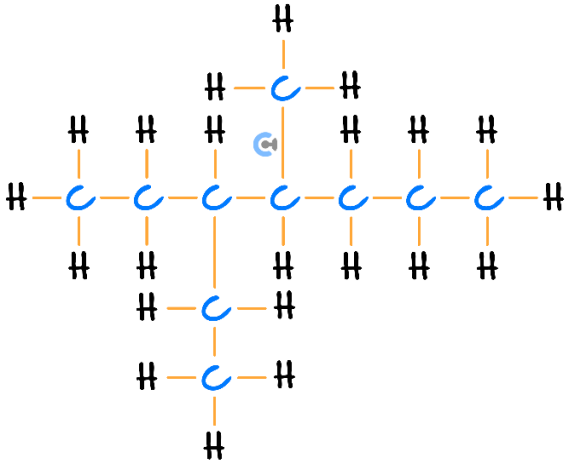
NOTE: Some teachers do not follow this rule and count the 'di-, tri- or tetra-', so be sure to check what your teacher wants and follow what they say for your SACs!

Your turn!

Question 9

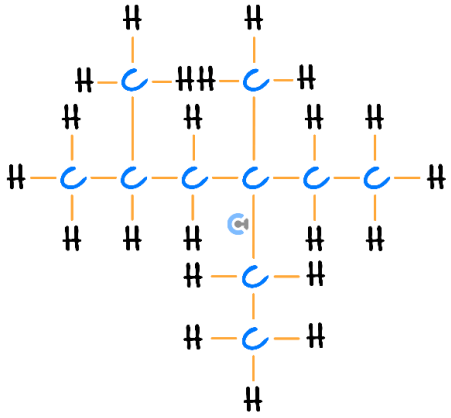
Name each of the following organic compounds and write their names and their semi-structural formulas.

a.



Name	Semi-Structural Formula

b.



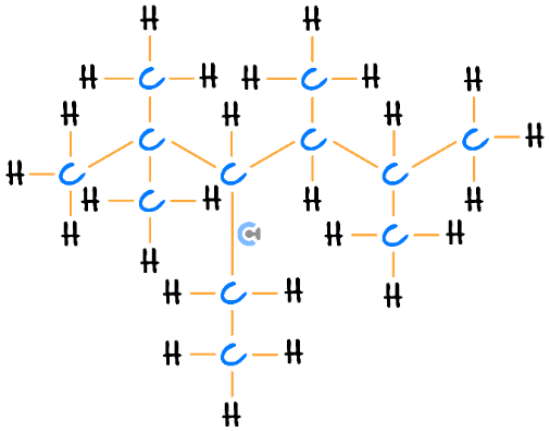
Name	Semi-Structural Formula

Space for Personal Notes

Question 10

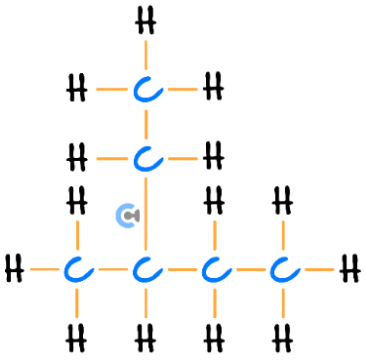
Name each of the following organic compounds and write their names and skeletal formulas.

a.



Name	Skeletal Formula

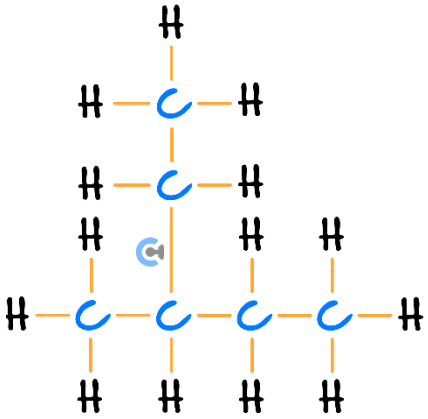
b.



Name	Skeletal Formula

Misconception

"The following molecule is named '2-ethylbutane."



TRUTH: Remember that the longest Carbon chain needs to be identified.

NOTE: The longest continuous carbon chain can be angled!

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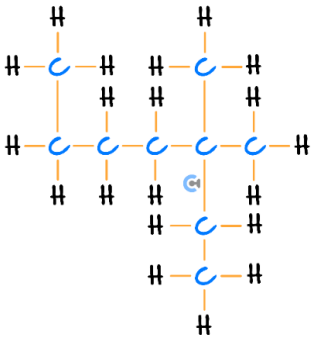
Your turn!

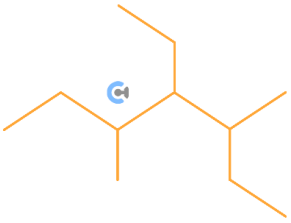
Question 11

Name each of the following from the provided structural, semi-structural or skeletal structures.

a.



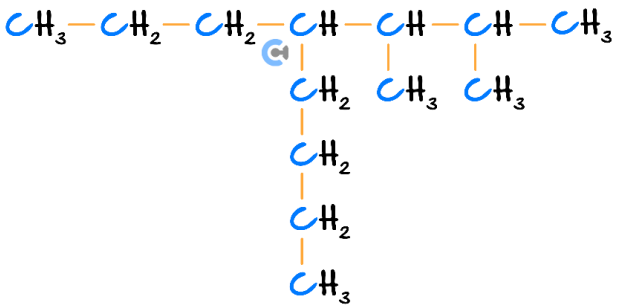
b.



c.

$CH_3CH(CH_3)CH(CH_3)CH_3$

d.



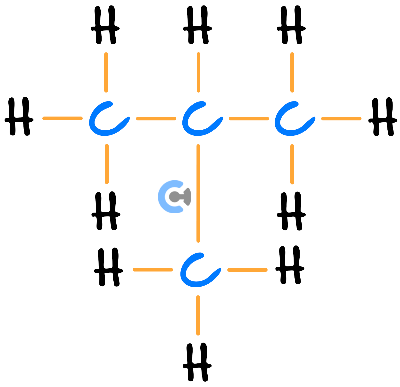
e.

TIP: Semi-structural formulas can be hard to visualise, so sketch the structural or skeletal structure on the side!

Space for Personal Notes

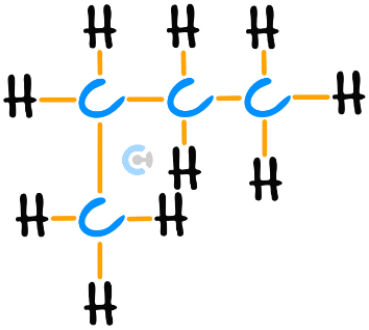
Misconception

"The following molecule is called 2-methylpropane."



TRUTH:

- Can the methyl group be placed on the first carbon?



- Name of "1-methylpropane": _____
- Methyl group can only be placed in **one** location (C-2), we _____ have to write the '2'.
- **Conclusion**: Considered wrong to write _____ numbers.
- **Actual Name**: _____

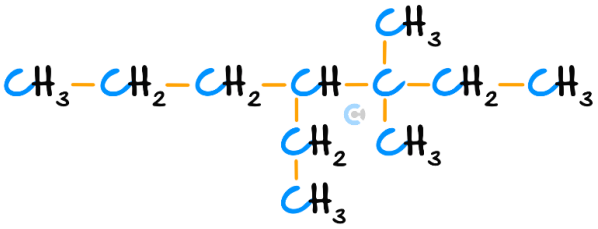
Space for Personal Notes

Your turn!

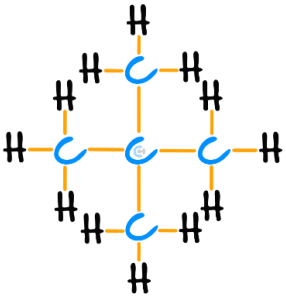
Question 12

Name each of the following:

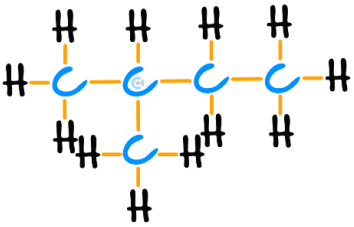
a.



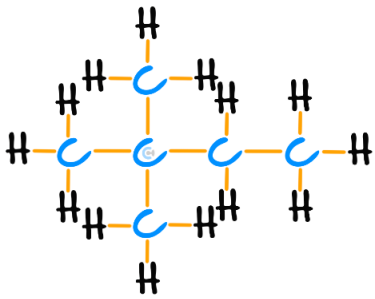
b.



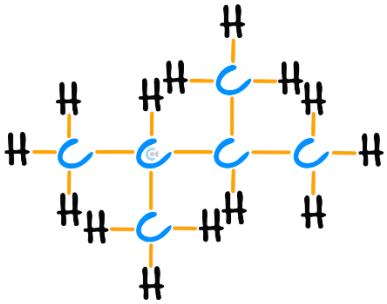
c.



d.



e.



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Section C: Haloalkanes or Alkyl Halides

Context

- **So far:** 'filling in' spare bonds by using hydrogens.
- **Alternative:** 'fill in' the spare bonds by using halogens.

Active Recall: What group are halogens in?

Periodic table of the elements

1 H 1.0 Hydrogen																	2 He 4.0 Helium
3 Li 6.9 Lithium	4 Be 9.0 Beryllium											5 B 10.8 Boron	6 C 12.0 Carbon	7 N 14.0 Nitrogen	8 O 16.0 Oxygen	9 F 19.0 Fluorine	10 Ne 20.2 Neon
11 Na 23.0 Sodium	12 Mg 24.3 Magnesium											13 Al 27.0 Aluminium	14 Si 28.1 Silicon	15 P 31.0 Phosphorus	16 S 32.1 Sulfur	17 Cl 35.5 Chlorine	18 Ar 39.9 Argon
19 K 39.1 Potassium	20 Ca 40.1 Calcium	21 Sc 45.0 Scandium	22 Ti 47.9 Titanium	23 V 50.9 Vanadium	24 Cr 52.0 Chromium	25 Mn 54.9 Manganese	26 Fe 55.8 Iron	27 Co 58.9 Cobalt	28 Ni 58.7 Nickel	29 Cu 63.5 Copper	30 Zn 65.4 Zinc	31 Ga 69.7 Gallium	32 Ge 72.6 Germanium	33 As 74.9 Arsenic	34 Se 79.0 Selenium	35 Br 79.9 Bromine	36 Kr 83.8 Krypton
37 Rb 85.5 Rubidium	38 Sr 87.6 Strontium	39 Y 88.9 Yttrium	40 Zr 91.2 Zirconium	41 Nb 92.9 Niobium	42 Mo 96.0 Molybdenum	43 Tc (98) Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57-71 Lanthanoids	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.8 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po (210) Polonium	85 At (210) Astatine	86 Rn (222) Radon
87 Fr (223) Francium	88 Ra (226) Radium	89-103 Actinoids	104 Rf (261) Rutherfordium	105 Db (262) Dubnium	106 Sg (266) Seaborgium	107 Bh (264) Bohrium	108 Hs (267) Hassium	109 Mt (268) Meitnerium	110 Ds (271) Darmstadtium	111 Rg (272) Roentgenium	112 Cn (285) Copernicium	113 Nh (280) Nihonium	114 Fl (289) Flerovium	115 Mc (289) Moscovium	116 Lv (292) Livermorium	117 Ts (294) Tennessine	118 Og (294) Oganesson

Atomic number: 79 — Symbol of element: Au — Relative atomic mass: 197.0 — Name of element: Gold

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm (145) Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.1 Ytterbium	71 Lu 175.0 Lutetium

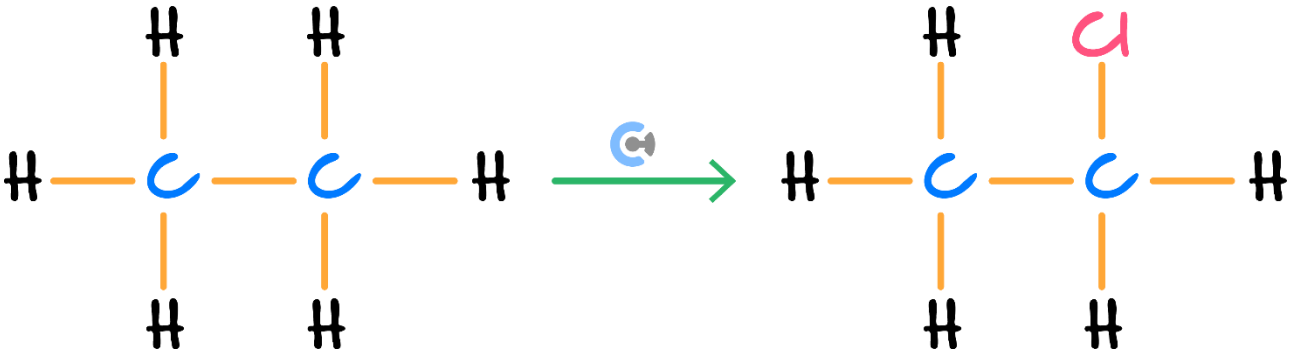
89 Ac (227) Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np (237) Neptunium	94 Pu (244) Plutonium	95 Am (243) Americium	96 Cm (247) Curium	97 Bk (247) Berkelium	98 Cf (251) Californium	99 Es (252) Einsteinium	100 Fm (257) Fermium	101 Md (258) Mendelevium	102 No (259) Nobelium	103 Lr (262) Lawrencium

The value in brackets indicates the mass number of the longest-lived isotope

Space for Personal Notes

Exploration: Halogens

- Consider **halogens**:
  - Valence electrons: _____
  - Covalent bonds: _____
- **Conclusion:** Hydrogen can be swapped out for a halogen. *(Highlight Below)*



NOTE: We'll cover how this exact reaction takes place in VCE Chemistry ¾ in Substitution reactions!

Analogy: Aussie Bogan

- Imagine your typical Australian Bogan whose name is 'Jonathan'.

- What is his nickname? _____
- This is how halogens are named!

Halogen Naming

- **Common halogens** covered in VCE Chemistry are:

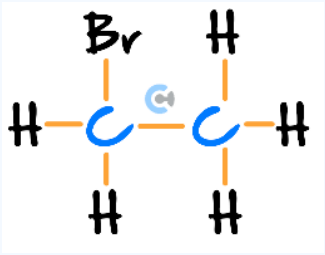
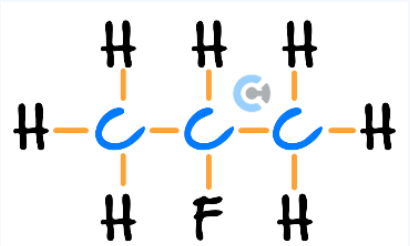
Halogen	Naming Prefix
Fluorine (F)	
Chlorine (Cl)	
Bromine (Br)	
Iodine (I)	

- The prefixes for halogens can be found on **page 15 of the Data Book**.

Space for Personal Notes

Let's have a look at two examples together!

Exploration: Structures of Haloalkanes

Arrangement 1	Arrangement 2
	
Name	Name
Semi-Structural Skeletal	Semi-Structural Skeletal

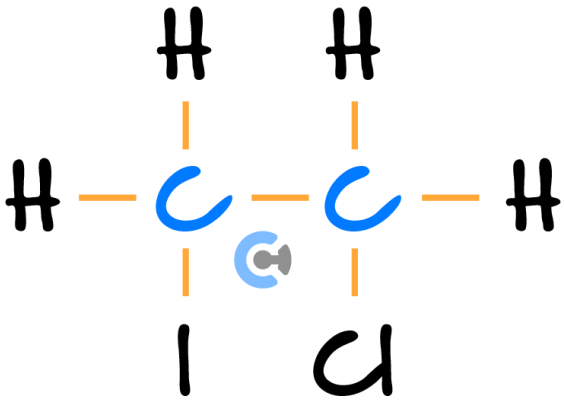
NOTE: When drawing skeletal structures, if elements other than carbon or hydrogen are used, they need to be **explicitly mentioned.**

ALSO NOTE: Halogens are simply added to the _____ of the name of the organic compound as a prefix.

Let's look at two more scenarios together!

Exploration: Haloalkane #1

- Consider:



- Just as how **long** the carbon chain length (**ethyl** vs methyl) was prioritised, the [lighter] / [heavier] substance is prioritised.
- **Priority** when **numbering:** [Iodine] / [Chlorine]
- Number each carbon on the molecule. *(Label Above)*
- When writing the **name** for the molecule, first **prefix:** [iodo-] / [chloro]
- Name: _____

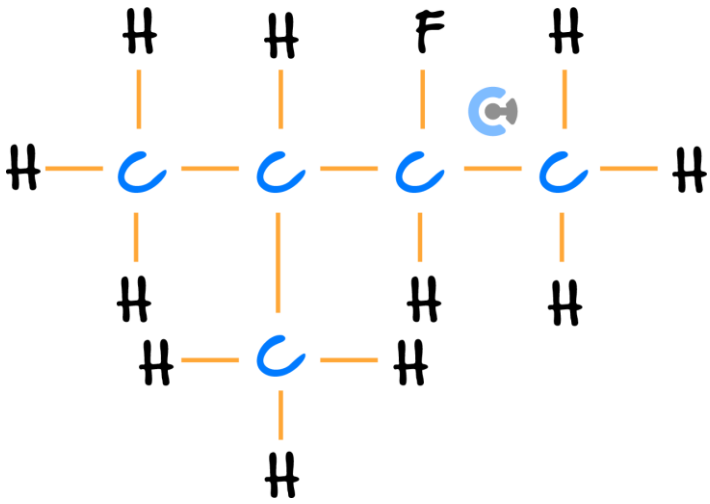
REMINDER: During naming, the prefixes are listed in alphabetical order!

Naming Haloalkanes

- **Naming Halogens:** Added to the [start] / [end] of the name as the **prefix.**
- **Prefix**: Abbreviate by adding an _____.
- **Numbering Priority**: [Lowest] / [Heaviest] atom / chain.

Exploration: Haloalkane #2

- Consider the following molecule:



- **Priority** when **numbering**: [methyl] / [fluorine]
- When **naming**, first **prefix**: [methyl-] / [flouro-]
- **Name:** _____

NOTE: Halogens [have] / [do not have] priority over alkyl groups when **numbering.**

TIP: In general, the following steps can be followed when trying to name organic molecules:

Identify longest continuous chain of carbon atoms which contains all functional groups → Identify side chains, functional groups & primary functional groups → Number carbon atoms in the chain to give lowest number to primary functional group → Name the molecule

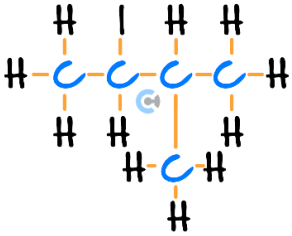
Space for Personal Notes

Try some questions!

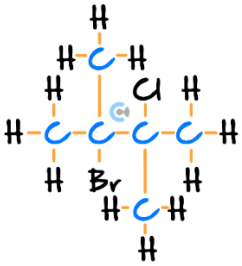
Question 13

Name each of the following:

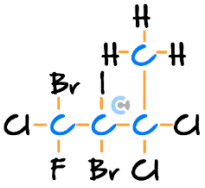
a.



b.



c.



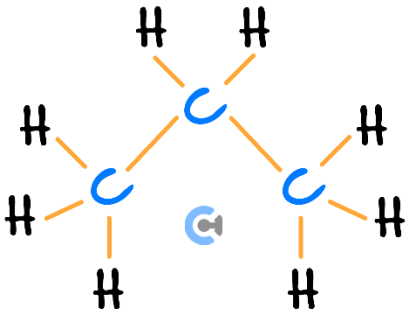
Section D: Ringed Molecules

Context

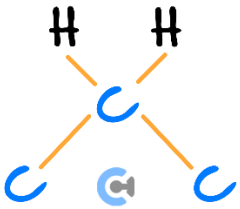
- **So far:** Linear molecules.
- **Reality:** Cyclic / ringed molecules.

Exploration: Ringed Molecules

- 'Linear' molecules start at one end and end at another:



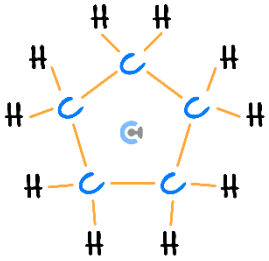
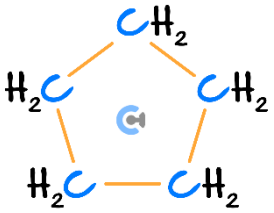
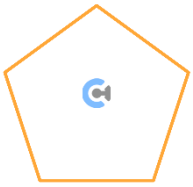
What if they link together?



- Instead of having a **chain** of carbons, it can also have a **ring** of carbons forming a closed loop.
- Called _____ or cyclic molecules.

Discussion: What is the minimum number of carbons required for cyclic molecules?

Exploration: Cyclic Molecules

Number of Carbons	3	4	5
Name			Cyclopentane
Structural Formula			
Semi-Structural Formula			
Skeletal Formula			
Molecular Formula			C_5H_{10}

TIP: When writing the semi-structural formula for cyclic molecules, the left groups should be written as "H_2C" instead of "CH_2".

Cyclic Molecules

- When naming cyclic molecules, simply add the prefix _____ in front of the molecule.
- The general molecular formula for cycloalkanes is _____.

NOTE: However, since the **naming** of cyclic molecules is not tested much in VCAA, this concept won't be explored much further!

Space for Personal Notes

Contour Check

☐ Learning Objective: [2.5.1] - Write molecular, structural, semi-structural and skeletal formulae of straight-chained & branched alkanes

Study Design

"Representations of organic compounds (structural formulas, semi-structural formulas) and naming according to the International Union of Pure and Applied Chemistry (IUPAC) systematic nomenclature (limited to non-cyclic compounds up to C8, and structural isomers up to C5)."

Key Takeaways

- ☐ Multiple ways to express an organic molecule:
- ☐ _____ formula lists the actual number of atoms in the compound.
- ☐ _____ formula shows the arrangement of all atoms and all bonds.
- ☐ _____ formula is a more **compact** way of drawing the structural formula and is also known as the _____ structural formula.
- ☐ It is written by writing the _____ of atoms surrounding each carbon atom.
- ☐ Skeletal structure: [do] / [do not] include **carbon** and **hydrogen**.
- ☐ Any intersection / end is assumed to be a _____ atom.
- ☐ The lines are assumed to be a _____ between adjacent carbon atoms.

☐ Learning Objective: [2.5.2] - Write IUPAC names of branched & unbranched alkanes

Study Design

"Representations of organic compounds (structural formulas, semi-structural formulas) and naming according to the International Union of Pure and Applied Chemistry (IUPAC) systematic nomenclature (limited to non-cyclic compounds up to C8, and structural isomers up to C5)."

Key Takeaways

Longest Carbon Chain Length	Prefix
1	
2	
3	
4	
5	
6	
7	
8	

- ☐ A hydrocarbon is an organic compound that consists only of the following elements:
  - _____
  - _____
- ☐ Alkanes are hydrocarbons with only _____ bonds.
- ☐ General molecular formula of an alkane is _____.

IUPAC Nomenclature:

- The [main] / [side] branch is typically the one with **less** carbons.
- Side branches are known as _____ chains, named using '-yl':
- The position of a branch is indicated by a number at the [beginning] / [end] of the name.
- There [are] / [are no] **spaces** in a name, apart from esters and carboxylic acids.
- Numbers and letters are separated by _____.
- If there is more than one type of functional group to be listed at the beginning of a name, they are listed in _____ order.
- More than one of the _____ types of functional group, the prefixes 'di-', 'tri-' or 'tetra-' are used.
- Numbers are separated from other numbers by _____.
- Two side chains of different lengths: Priority is given to the [shorter] / [longer] side chain.
- When naming, [do] / [do not] count 'di-, tri- or tetra-' when comparing alphabetical order.
- When alkyl / functional groups can only have a **specific** pre-determined location, beware of _____ numbers.

☐ Learning Objective: [2.5.3] – Write molecular, structural, semi-structural and skeletal formulae of straight-chained & branched haloalkanes

Study Design

"The grouping of hydrocarbon compounds into families (alkanes, haloalkanes, alkenes, alcohols, carboxylic acids) based upon similarities in their physical and chemical properties, including general formulas and general uses based on their properties."

Key Takeaways

- ☐ Halogens are found in Group _____ and can thus form _____ covalent bond with a hydrocarbon chain to form a **haloalkane.**
- ☐ Haloalkanes follow all the same general rules as alkanes.
- ☐ When drawing skeletal structures, if elements other than carbon or hydrogen are used, they [need] / [do not need] to be **explicitly mentioned.**

☐ Learning Objective: [2.5.4] - Write IUPAC names OF branched & unbranched haloalkanes

Study Design

"Representations of organic compounds (structural formulas, semi-structural formulas) and naming according to the International Union of Pure and Applied Chemistry (IUPAC) systematic nomenclature (limited to non-cyclic compounds up to C8, and structural isomers up to C5)."

Key Takeaways

- ☐ Halogens are simply added to the _____ of the name of the organic compound as a **prefix.**
- ☐ They are named by abbreviating the halogen's name and adding an _____.
- ☐ When **numbering**, the [lowest] / [heaviest] atom / chain gets priority.
- ☐ Halogens [have] / [do not have] priority over alkyl groups when **numbering**.
- ☐ If there is more than one type of functional group to be listed at the beginning of a name, they are listed in _____ order.

Learning Objective: [2.5.5] – Identify and draw simple cycloalkanes & write their IUPAC names

Study Design

"Representations of organic compounds (structural formulas, semi-structural formulas) and naming according to the International Union of Pure and Applied Chemistry (IUPAC) systematic nomenclature (limited to non-cyclic compounds up to C8, and structural isomers up to C5)."

Key Takeaways

- Instead of having a **chain** of carbons, can also have a _____ of carbons forming a closed loop, creating a cyclic / ringed molecule.
- When naming cyclic molecules, simply add the prefix _____ in front of the molecule.
- The general molecular formula for cycloalkanes is _____.

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